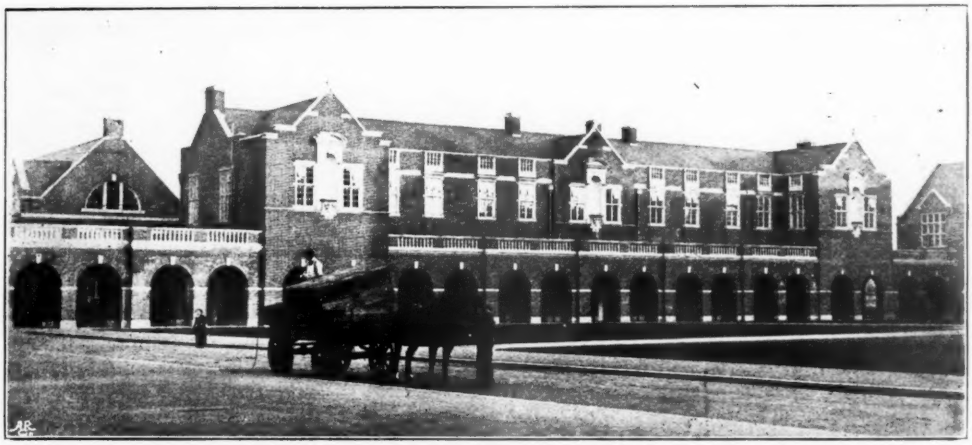


Christ's Hospital School, Horsham: Front View of the Science Block from the Quadrangle. (From a Photograph by Mr. Chas. E. Browne, the Senior Science Master, to whom the Author is indebted for the Photographs illustrating this Paper.)

SCIENCE WORKSHOPS FOR SCHOOLS AND COLLEGES.

By Professor Henry E. Armstrong, LL.D., Ph.D., F.R.S.

Read before the Royal Institute of British Architects, Monday, 19th January 1903.

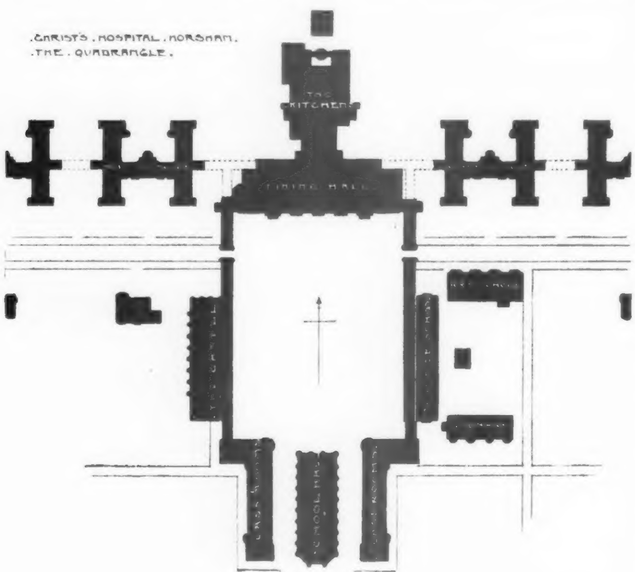
THE importance of experimental studies carried on with the object of affording training in scientific method, as a necessary part of the ordinary course in schools generally, whatever their grade, is already so widely recognised that ere long every school will certainly need its *workshops* as well as its *class-rooms*; it is therefore desirable that the general character of the requirements should be understood, in order that buildings may be properly designed to accommodate all necessary fittings and appurtenances—and more particularly to afford the necessary working space.

In preparing such a statement, it is well to look ahead and to foreshadow the policy of the future, as the whole question of school design may assume a very different aspect in years to come; indeed, the architect may play a by no means unimportant part in helping on reforms which many think to be very necessary if practical work is to take its proper place in the ordinary curriculum of every school.

I propose to illustrate my arguments largely by reference to the new buildings at Horsham for Christ's Hospital School, which have been erected from the designs of your President and Mr. Ingress Bell to accommodate 820 boys. When the position and size of the Science Block (see plan, p. 166) with reference to the other school buildings are noted, it will be obvious that extraordinary importance will be attached to experimental studies in this school. The Science Block occupies practically one side of the quadrangle; the opposite side is occupied by the Chapel, the Class-Rooms and School-Hall filling the third, the Dining Hall the fourth side. The floor area of the ordinary class-rooms is 15,482 square feet, that of the rooms in the Science Block is 10,326 square feet, the area of the four large rooms—the science class-rooms proper—in which the boys usually work being about 8,200 square feet. The importance of the Science Block will also be obvious when the elevation is contrasted with those of the other buildings surrounding the quadrangle.

But the provision which will be made at Horsham for work such as I am contemplating will not be confined to the Science Block. At no distant date, I trust, there will be distinct workshops for manual training in wood and metal; and the engineering appliances generally will afford opportunities for the instruction of the more advanced boys in the use of machinery. Moreover, surveying and map making will be practised in the country round, and there will be abundant opportunity for other out-of-door studies; besides school gardens, a set of experimental plots are now being laid down on the lines of those at the Rothamsted Agricultural Station which have so world-wide a renown.

Christ's Hospital School, in fact, ere many years are past, should be a model school; and it is because the buildings illustrate so many important points that I propose to refer particularly to them. I am the more inclined to do so as the Christ's Hospital buildings mark an extraordinary advance—far greater than most of those who are connected with them have realised, I think.



I may be allowed here to say how much, as one of the Governing Body, I appreciate the great work which your President and his colleague have carried out; and that in watching the progress of the buildings from the time since the foundation-stone was laid to the present day I have never been without occasion to wonder how many things the architect must be to all men.

School work hitherto has been sedentary work; provision has been made almost exclusively for the use of books, slates, pens, ink, and paper. During school hours boys and girls have been almost chained to their desks like galley slaves; although laboratories for the instruction in science, workshops for manual training, have been introduced here and there, the space provided in most cases has been very small; and the allowance of time for practical studies has been on a most niggardly scale. I heard it said recently that one of the most distinguished head masters of the day had summed up his educational creed in the words "Latin and the cane;" and although fashion forbids the latter—perhaps unfortunately—the pernicious belief in the all-sufficing efficiency of the classics as a means of culture is still with us: obviously no very special provision need be made so long as such simple weapons were alone to be used.

Our schools are too frequently in the hands of men who have not had a practical training; but probably the coming generation will order things otherwise. We are, in fact, now beginning to recognise that the clerical methods adopted almost exclusively in the past must be modified—that it will not do to train our boys as though all were to be clerks or our girls as though all were to be teachers, telegraphists, or type-writers; but that men and women have practical instincts which must be developed if they are to do their work in the

world efficiently. The consequences of an unpractical system of training are rapidly becoming more and more serious on account of the extraordinary extent to which in these days the subdivision of labour is carried—so that few have sufficient opportunity of learning in that most practical of all schools, the school of experience. The teacher must be encouraged to be practical in every possible way. Even in the case of man teachers of the ordinary subjects, time is so fully occupied that they have little opportunity of paying attention to external conditions and requirements; women teachers are placed at a still greater disadvantage: as they are usually selected from a studious literary type, the tendency on their part to worship unpractical ideals becomes almost overwhelming and it is not surprising that so little attention is paid to domestic interests by our girls' schools. Architects more than most professional men can appreciate the value of practical knowledge as well as the danger of following academic traditions; and it is important that they should be alive to their opportunities as well as to their responsibilities. By making practical provision for practical teaching when called on to advise school authorities, they will be exercising a most important influence; and it is on this account that I venture to submit these remarks.

I may quote one or two witnesses in support of my contention. Sir J. Wolfe Barry, a few days ago, in delivering the Presidential Address to the Association of Technical Institutions, said, "We desire to see in this country what was so observable in America—namely that almost everyone was a mechanic and knew something of applied science."

At the recent Conference on the Training of Teachers at Cambridge, Mr. Sadler, the editor of the well-known special Reports on educational subjects published by the Board of Education, spoke of the new forces of educational thought as "moving towards the recognition of manual and practical work as necessary elements in all education, even in some degree in that provided for boys of literary aptitude and of non-mechanical tastes."

Sir John Gorst, at the same meeting, expressed the opinion that what I have called the workshop method—"the method of teaching the young to find out things for themselves and to apply the knowledge which they themselves have acquired to the solution of practical problems—is a method of education which is very likely to be heard a great deal more of in the course of the next generation."

At the Conference of Teachers held at Manchester at Christmas, the Head Mistress of the Manchester High School for Girls, Miss Burstall, recommended that one-third of the school-time should be given up to practical studies. In comparison with the one or two hours a week grudgingly granted in the public schools to such work, this is a remarkable advance.

But we are not only becoming more practical in our views as to the general character of the school training of the future: our conceptions are also broadening in other directions, especially with regard to the way in which "science" should be taught; with regard to the extent to which freedom may be granted to the scholars; with regard to the relation which the various subjects taught in schools should have to one another.

In the past it has been customary to teach some branch of science—usually either chemistry or physics or both—and laboratories have been required for this purpose; in fact, the word *laboratory* has a specific connotation in connection with the teaching or practice of some branch of experimental or observational science. Unfortunately, in introducing experimental science into schools, the mistake has been made of merely transferring red-hot embers from the university or college and then proceeding to keep the fire burning on the professional lines followed in the technical school. We are being led gradually to see that this mistake must be rectified—that it is not the province of schools to teach any branch of science technically or even specifically. We desire, in fact, to get rid of formal science and to give broad training in scientific method—to subject the young scholars to the practical discipline to be

derived from experimental studies; we do not wish to make specialists of them. A step is gained by substituting the word workshop for laboratory: by so doing we not only make use of a word which is familiar to English ears, but gain an enlarged and more definite conception of the kind of work to be done. Everyone thinks of work done in the class-room as different from that done in the workshop. It is material to my argument that in the workshop the onus is cast on the worker rather than on the director: one of the chief objects of introducing experimental studies into schools is to train boys and girls to be self-helpful.

At Christ's Hospital the four chief rooms in the Science Block are called Science Workshops and are distinguished by the names of Cavendish, Dalton, Davy, and Faraday—all classic names in the history of English science.

If the work done in the school workshops is to be of a general character, it is obvious that the fittings must be planned and arranged accordingly.

In the past, as a rule, subjects have been taught in watertight compartments; but there is a growing tendency to co-ordinate much of the teaching, especially in the junior classes. Thus, mathematics has been taught in the class-room as a desk subject, whilst elementary physical measurements which have been neither more nor less than practical mathematical exercises have been carried on in the laboratory under the science teacher. It is urged—and with force—that the teacher of mathematics must adopt practical methods and relieve the teacher of science of much that now falls to his share. Clearly, one of two courses must be adopted—either the necessary provision must be made in the mathematics class-room for the practical study of the subject or a large part of the mathematical teaching must be transferred to the science workshop. A good deal of drawing is now done incidentally in the course of the science lessons; and gradually we are also recognising that the science work has a literary side. Everything points, in fact, to a time when class-rooms such as are now provided will be of subordinate importance in our English educational system—to a time when we shall justify our contention that we are a practical people.

To summarise my recommendations, I would say that in designing science workshops the architect and his technical advisers should have three S's in mind—*Sense*, *Simplicity*, and *Space*. There should be due knowledge and understanding of the requirements to be met—mere copying should be impossible. The provision made should be of the simplest character possible—because simplicity of provision conduces to simplicity of practice; and the space should be ample—for almost anything may be done, given sufficient space, and to grant proper space is to show proper respect.

It is not my province to consider external design or general architectural effect, but I will venture to urge that money spent on judicious ornamentation is always well spent in the case of a school. We give far too little heed to the influence which surroundings exercise on young people; and if we are ever to recover the sense of artistic feeling, we must do far more to make our schools attractive. The disregard of property which seems to be so characteristic of boys at the present day—which leads them to kick open doors, to wipe their feet on the railway carriage seats, &c.—is probably a consequence of the fact that at school they are not placed under conditions which would lead them to be mindful of their surroundings. It is astonishing that the example set by Thring at Uppingham has met with so few followers hitherto: "thinking in shape" such as he advocated is one of the most powerful means of stimulating the imagination and of developing æsthetic tastes; and it is so easy to carry out his idea in these days, as magnificent photographic reproductions of the masterpieces of Nature and of Art are to be had at comparatively small cost. The moral of these remarks is that neither class-room nor corridor should be without its picture rail. I would also plead for a more liberal use of colour and of line decoration in our schools.

Before describing the science workshops at Christ's Hospital, I should say that the fittings were not thought of until long after the building was designed. Of course, to secure the best result "the punishment should fit the crime"—the building should be designed to the fittings, not *vice versa*.

They differ in an important manner from the laboratories hitherto provided for schools. On reference to the plans, it will be seen that there are four main rooms in which classes are held; and that to each of these are attached a number of subsidiary rooms.

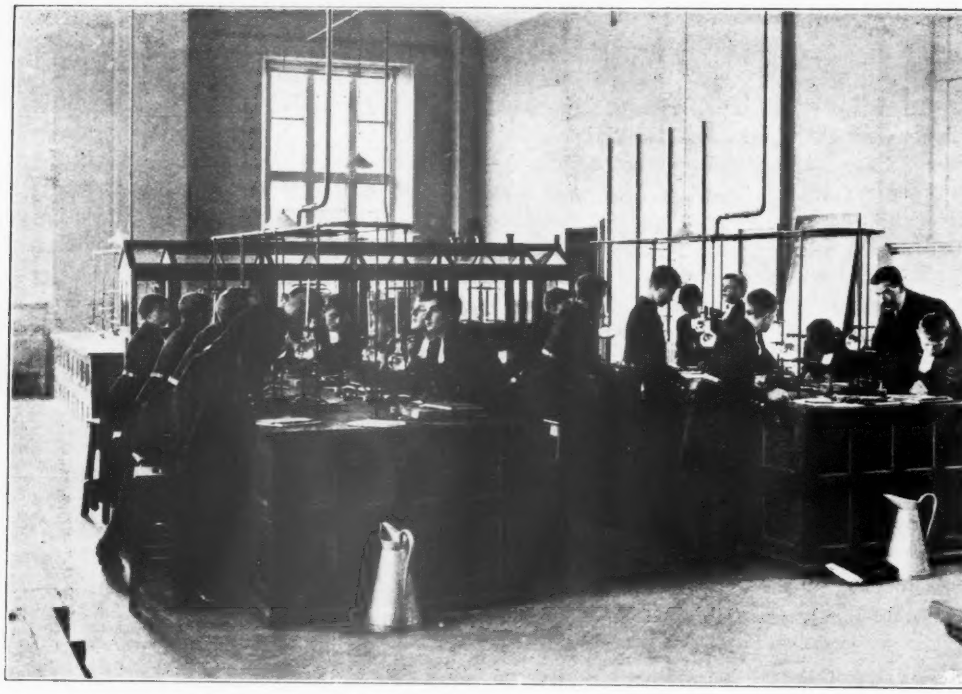
No lecture room is provided; the omission has been made of set purpose, as it was desired to discourage didactic teaching. The object of introducing experimental science into schools is to give boys and girls an opportunity of learning to do things themselves; the time devoted to such work is brief enough, and they cannot afford to waste any of it in listening to formal lectures. Full provision is made in each room for such didactic teaching as may be necessary by providing a demonstration bench, in front of which there is sufficient space left free for seats in two of the rooms, whilst in the others uprights are fixed, provided with small desk tops, at which the class can stand and take notes.

Moreover, no special balance room is provided; instead of such a room, a novel fitting—a balance bench—has been introduced. At first this was provided only in the two of the four workshops which were intended for juniors, but it has been found so useful that a third has been ordered, which is to be placed in the Faraday workshop. The balance bench is merely a long narrow table (2 feet by 12 feet by 3 feet 6 inches high) covered by a glazed case for the protection of the balances. In fact, instead of having a number of balances within separate glazed cases, one large glazed case has been provided to contain a number of separate uncased balances. The balance table is approached on either side from the working benches and is arranged at right angles to these. Four boys can work at either side and one at each end. The glazed fronts are hinged at the bottom to the table top and drop down. Holes are made in the table top wherever desirable underneath the balance pans, so that objects may be suspended from the balance pan and weighed, for example, in a pail of water underneath the table. The arrangement has the great advantage that the teacher has the scholars under complete control and is able to see whether they are weighing properly. The balances placed in such a case are those required for all ordinary work. There is no difficulty in dealing with the more delicate balances required for advanced work: these are always provided with a case; and as the sensitive working parts are of agate, there is no need to keep them in a separate room. They are conveniently placed on brackets against the wall.

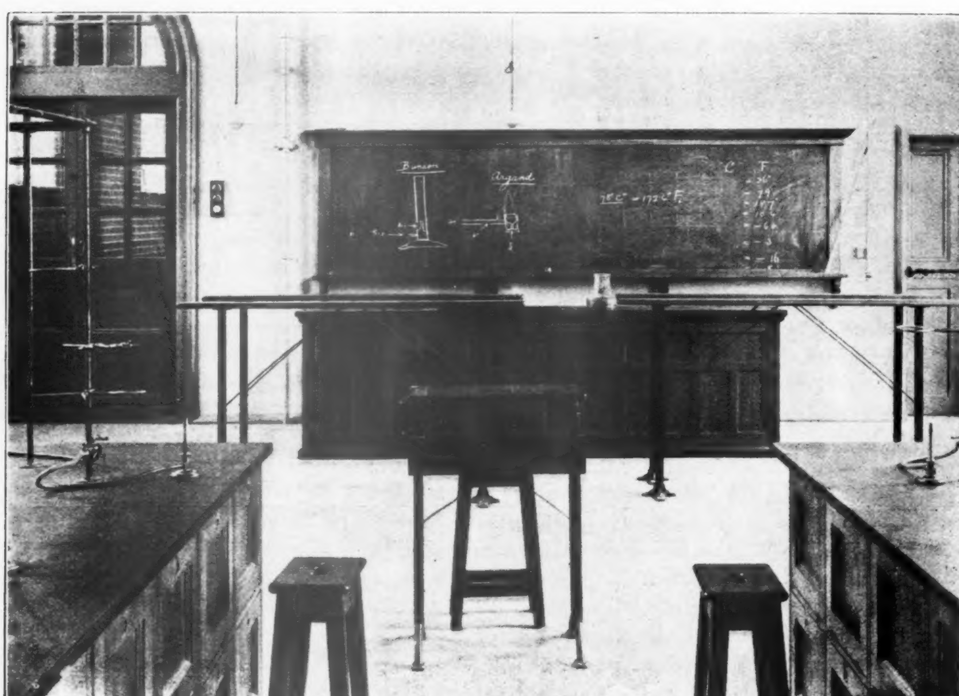
Store Room.—A third special feature of importance is the store or stock room attached to each of the four workshops. This is intended not only for the ordinary stores but also as a room in which the apparatus for experiments left unfinished at the end of a lesson may be set aside until the next attendance.

Working Benches.—These are of two kinds—those for ordinary work and those at which work involving the use of water may be done. The distinction is fundamental, I think. The former have teak tops; the latter are covered with lead. In days gone by, when the only science taught was analytical chemistry, there was much washing out of test tubes to be done: consequently numerous sinks were provided. To the present day, the regulations of the science branch of the Education Department specify that there should be a water-tap and sink for every two students, but fortunately the rule is qualified by an "if possible."

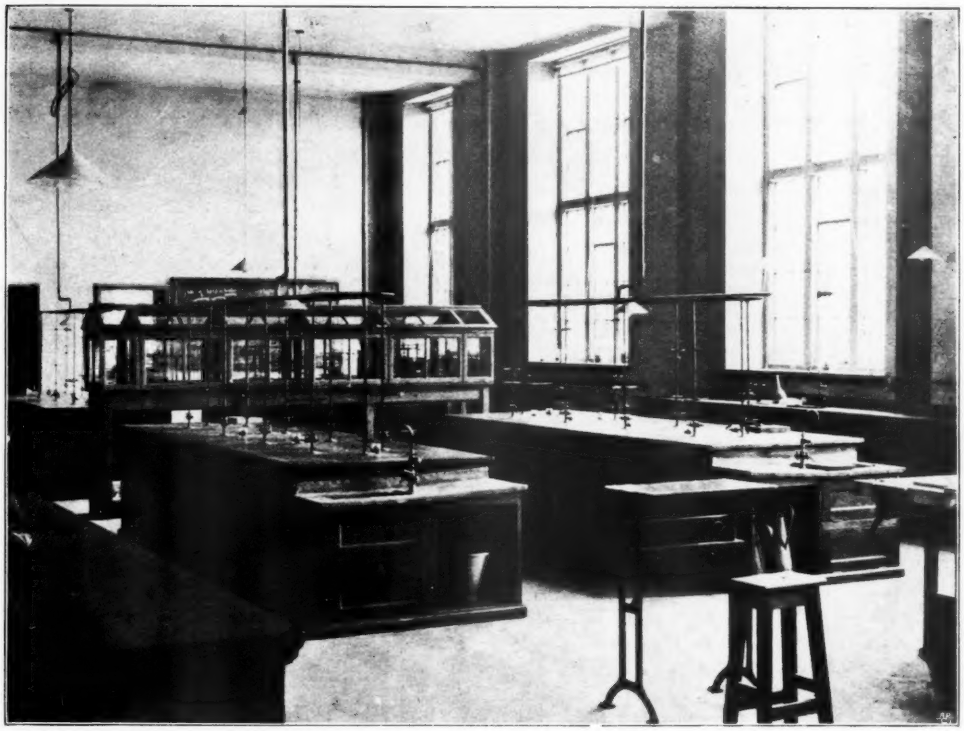
If only to prevent the general but inexcusable habit of wasting water from growing up, this regulation should be abolished. It is the more necessary to get rid of such a regulation, as it has done much in the past—and is still doing much—towards retarding the proper teaching of science in schools, on account of the expense involved in carrying it into execution; and it has



BENCH IN DALTON WORKSHOP, SHOWING THE USE MADE OF THE GAS STANDARDS AS SUPPORTS, ETC.



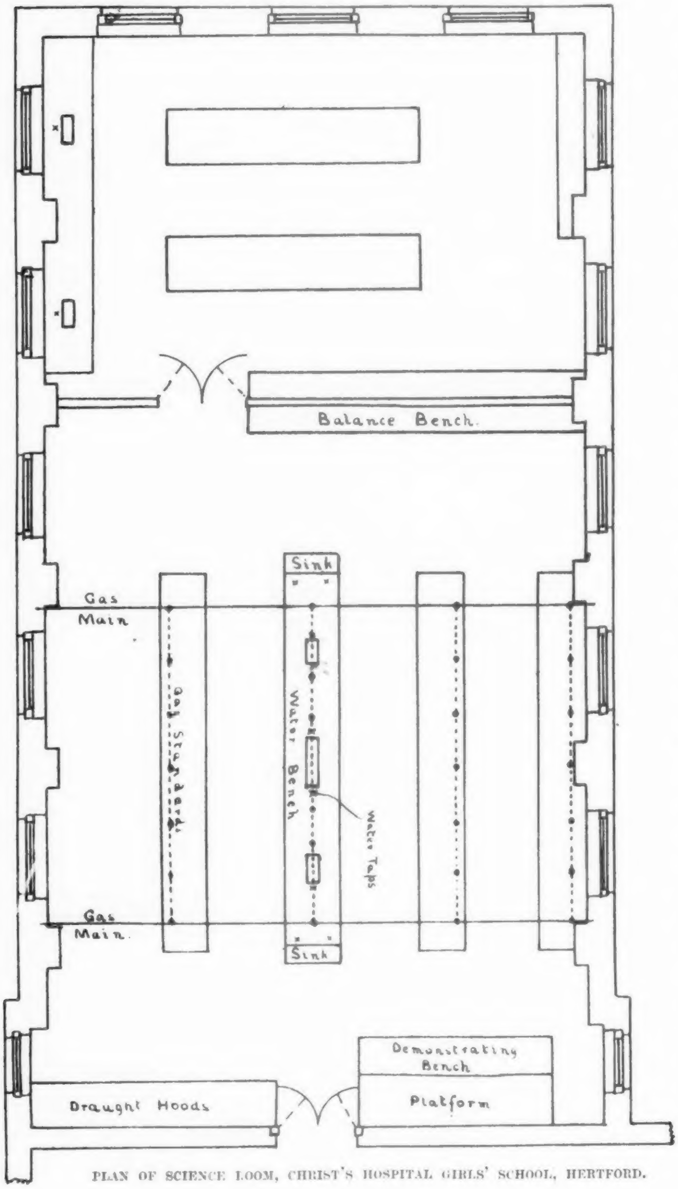
DEMONSTRATION TABLE IN DALTON WORKSHOP, SHOWING RAIL AT WHICH THE BOYS STAND. THE CONSTRUCTION OF THE CUPBOARDS UNDER THE BENCHES IS WELL BROUGHT OUT.



BENCH IN CAVENDISH WORKSHOP, SHOWING THE ARRANGEMENT OF THE GAS STANDARDS AND THE SINKS AT THE ENDS, AS WELL AS THE BALANCE BENCH.

LARGE SINK AND PORTION OF VENTILATION HOOD IN CORNER OF DALTON WORKSHOP.

given rise to numerous disputes, sensible people seeing that such provision is quite unnecessary. Besides the intolerable waste of water, the presence of sinks on the benches involves the constant wetting of the bench near the sink. Fortunately, the class of work now advocated for schools requires the use of water but seldom, so that there is no longer any excuse for providing sinks except in special places. But I would warn architects that they must harden their hearts on this point—as they will meet with many unimaginative teachers who will hanker after what has been, whilst others will think it so convenient to have sinks here, there, and everywhere if they do not object to allow scholars to move a few feet towards a convenience. There is no more reason, however, why sinks should be everywhere in a laboratory than there is to have one in every room in a dwelling-house so that all washing up may be done on the spot. I need scarcely point out that the economy involved in localising the water supply, sinks, and drains is very great. At Horsham, in the rooms on the upper floor, all sinks have been placed near to the walls, and the waste is carried down to the floor below in pipes fixed in chases in the walls. On the basement floor, cross channels have been avoided as much as possible.



PLAN OF SCIENCE ROOM, CHRIST'S HOSPITAL GIRLS' SCHOOL, HERTFORD.

The conventional top namper which is erected on the bench in most laboratories has been got rid of; in three of the rooms an arrangement has been substituted which provides both

a gas service and upright supports to which the rings &c. required to hold apparatus can be clamped. Uprights made of quarter-inch iron gas barrel have been bolted to the table top 1 foot 6 inches from the outer edge, at intervals of about 3 feet. A few inches above the top these are fitted with crosses into each of which two eighth-inch bore gas taps (Baird and Tatlock's) are screwed. At the top, these uprights are connected together by half-inch barrel. These cross-connections form a complete circuit, which in turn is connected with the gas main brought down from the ceiling. By bridging the interval at the top by pieces of board, shelves are formed on which, for example, a vessel to be used as a reservoir may be placed; or pulleys &c. may be hung from the cross pipes, which form a gallows along the whole length of the table. If bottles are needed these can be arranged inside the uprights along the middle of the bench. If it be desired to produce a decorative effect and to protect the wood against acids, white glazed tiles having pieces of indiarubber glued to the underside by bicycle cement may be arranged within the line of uprights. What is wanted on a school bench is working space; shelves only serve to obstruct the view and to carry bottles which are rarely used.

The arrangement which I am here advocating has been carried out in a slightly different way at the Christ's Hospital Girls' School, Hertford, in the new science room designed by Mr. Stenning (see plan, p. 172). Four parallel benches about 20 feet long are arranged along the length of the room. That at the windows is suitable for senior work. The remaining three are so placed that girls may work facing the light, standing against the inside edge of the two outer benches, which have wooden tops and are provided with gas but not with water; the middle bench is covered with lead and there are three sinks in it and a larger sink at either end. The girls can turn from the *working bench* to the *water bench* whenever necessary, the one water bench serving for the common use of the two sets of girls. The sinks in this bench are mainly for use as pneumatic troughs: two are 1 foot 6 inches, and one is 2 feet 6 inches long. I venture to think some such arrangement as this is about the simplest and most common-sense plan that can well be adopted. The tops of the working benches overlap the cupboards 6 inches, so that the girls may sit and write at them. The gas standards are fixed 6 inches from the outer edge and are tied by the overhead mains which run along the benches and across the room.

Cupboards.—Both at Horsham and Hertford, the space below the bench top is fitted with two tiers of small cupboards; inside each cupboard there is a small drawer. Each working place has four such cupboards, so that four scholars may occupy the place in succession and each have a cupboard to dispose of. In the case of school work, the amount of apparatus to be stored by the individual scholar is usually small.

Sinks and Drains.—The ordinary earthenware sinks are not only more or less fragile themselves, but when glass objects are dropped into them these are invariably broken; moreover, the connection with the drain is difficult to make and always a source of weakness. Lead-lined sinks are in some respects better but not altogether satisfactory. Thirty years' experience has convinced me that wooden sinks are far the best—provided that they are built up solidly without dovetailed joints and that they are always kept partly full of water by arranging the waste so that it projects several inches (about four) above the bottom of the sink. American white wood seems to be one of the best to use. Sides and bottom should be without joints. All surfaces should be well painted with thin coal tar before they are butted; and the whole surface inside and out should be similarly coated. The waste-pipe should either be somewhat expanded or should have a conical flange burnt on by means of which it may be held in position by two blocks, one of which—fixed by screws to the under side of the bottom—serves to carry bolts by means of which a second block is caused to clamp the pipe firmly. The space between the pipe and the side of the hole through which the pipe passes is filled

in with pitch. The sink is wedged up against the bench top. Such sinks may be made of any size that may be desired, and no plumber is needed to fix them. The best drain, in my experience, is a U-shaped channel formed in a concrete floor, lined with the best Portland cement and then well tarred when dry. It should be provided with a wooden cover-plate. Such a drain can always be got at. Each year during the long vacation it should be cleaned and when dry recoated with tar.*

Ventilation Hoods.—One or more of these have been provided for each of the four large workshops, but they are not yet finally arranged. Their position has been determined by that of the flues, which are not always in ideal situations. Had the fact been sufficiently taken into consideration that electricity is at disposal, there can be little doubt that the use of electrically driven fans would have been provided for from the outset and that the attempt would not have been made to produce a draught by means of gas. The trials made thus far have proved that it is desirable to use fans.

The conventional ventilation hood has many faults which are perpetuated time after time; of all the fittings it is the one which most needs study and improvement. The hood is rarely properly proportioned to the work for which it is to be used; and the mistake is almost invariably made of merely providing an exit opening without reference to its position or shape. The improvement, first introduced, I believe, at the Finsbury Technical College and subsequently at the Central Technical College—which is described in Robins's *Technical School and College Building* (Whittaker & Co.: London, 1887), p. 123, plate 50—appears to have passed unnoticed. It consists in giving the flue exit opening the form of a slot extending across the hood, so that an even draught may be produced extending from side to side of the cupboard. The squeegee fitted to the upper bar, blocking the interval between the glass of the rising sash and the bar in front of which the sash moves up and down, is another feature of importance which has been overlooked. The use of iron plates for the roof—and in many cases for the ends—may be recommended. It is easy to construct a slot flue exit in the angle which the iron roof plate forms with the wall by fixing an iron plate against the wall inclined outwards at the angle which will give a slot of the size necessary to secure an even draught from end to end, the size of the opening being determined by trial. The opening into the flue may be at any point inside the V-shaped flue-box which is thus formed. The gas-burner should always be placed below the opening from the closet into the upcast flue.

Much remains to be learnt as to the manner in which flues should be constructed for draught hoods. It is the case of the smoky chimney over again: some hoods work well, others badly, no one knowing precisely why. The subject needs to be taken in hand experimentally, and it is important that it should be studied. In any case, flues should be made wherever possible in the walls: they are always useful.

One other point of special importance may be referred to. Whatever may be the system of ventilation adopted, there should be no competition between the exits; if provision be made for the *extraction* of the air from a room by mechanical means independently of the hoods, it cannot be expected that the flues of draught hoods will work with full efficiency, if at all; the air should be allowed to escape through open windows, if not entirely through the draught hoods.

Of the two systems available—that in which the draught is secured by means of a gas

* Care should be taken to arrange the drains so that they come *outside* the benches, in order that they may be easily got at. If there be any difficulty in so placing them, it is better to form a channel in the top of the bench at the back or down the middle of a double bench; this may be arranged to drain into a sink at the end of the bench, if sinks are required. Such channels are very easily provided when the bench top is covered with lead. All pipes, whether for gas or water, should be of iron. They should be fixed on the face of the walls and above the bench-top. It is all-important not to fix such fittings within the cupboards. Sinks such as I have described have been made to my entire satisfaction by the Bennet Furnishing Company.

jet and that in which a fan is used—it may be said that each has its advantages. If the latter be adopted, it will, I think, be found advisable to localise the draught closets, much as I have advocated should be done in the case of water supply, &c., otherwise the cost of fans, and particularly the cost of working them if electricity be used, becomes excessive. I may add that to connect up a series of hoods in different parts of a room or building and to use one large fan to produce a draught through all is not really satisfactory in practice; moreover, the construction of the necessary flues introduces special difficulties and is costly.

The use of gas has the advantage that small hoods may be worked economically—so that they are to be recommended in cases in which only the occasional use of the draught hood is contemplated. But I may here utter the caution that no acid fumes should be allowed to escape into the air and that draught hoods are therefore essential wherever chemical work is to be done. I am sure it will be found in cases where electric lighting is adopted that the wiring will perish rapidly unless the precaution be taken to soak the leads in molten paraffin wax before fixing.

Special Appliances.—At Horsham, a carpenter's bench with four vices is placed in two of the rooms (Cavendish and Dalton), provision being made for storing tools and other general requisites in drawers and cupboards in the somewhat specially fitted bench marked "Bench with zinc top." The top of this bench, it may be mentioned, is intended for use in cutting out cardboard &c.

A small room on the extreme left of the ground floor is fitted with two lathes (wood and metal), a drill and a circular saw, which are driven by an electro-motor. As the man in charge of the workshops is a skilled mechanic, it will be possible to have a good deal of simple apparatus made on the spot by the boys—so that the manual training work will to some extent be co-ordinated with the experimental work.

A dark room for optical experiments has been partitioned off from the Faraday workshop. A dark room for photographic work is provided on the upper floor. This latter, it may be pointed out, is an all-important adjunct to the science workshops.

Arrangements for muffle and other furnaces are being made in several of the rooms.

The experience I have of school requirements, especially that gained of late in arranging the fittings at Horsham and Hertford, leads me to think that, by taking into account more carefully than has hitherto been done the character of the fittings to be introduced at the time of designing the building, it will in future be possible to improve considerably upon the arrangements which have been made in the Christ's Hospital Schools, especially in the direction of simplification.

The ideal to be aimed at, I think, is to have the whole of the room, both floor and wall space, available for the work which is to be done in it.

Wall space is invaluable for a variety of purposes—for many mechanical and physical experiments, for black boards, for shelving, &c. I would, therefore, advocate that no benches should be fixed permanently against the walls, but that all benches should be placed out in the room; also that projections into the room should be avoided and that the windows should be inserted at least six feet above the floor. There would then be an uninterrupted wall space at disposal on all sides of the room.

Whenever possible, the steam or hot-water pipes for heating the room should be carried under gratings in channels in the floor. Radiators &c. not only take up much space against the wall, but interfere with and damage fittings in their neighbourhood.

As to benches, I am much inclined to question the need of the elaborate provision which we have hitherto made. It is doubtful whether cupboards are required under the benches in schools; apart from the fact that there is not much to be stored by the individual scholar,

cupboards tend to engender habits of untidiness—everything gets put away into them and the teacher cannot be perpetually looking after them. It is desirable to encourage the common use of apparatus and the habit of keeping things in set places and in good order. If sufficient shelving, racks, &c. be provided and cupboards for general use where necessary, there is little need for cupboards under the benches. In cases where it is necessary to put certain tools &c. in the hands of each scholar, it would be easy to provide simple lockers against the wall or even to give each scholar a box which could be taken "out of store" at each attendance and put under the working bench during the lesson.

I should like to see steady heavy benches of the kitchen-table type made use of in many, if not in most, cases. I have spoken already of the concentration of water supply and sinks. As to gas supply, of course it is convenient to have it at all benches; and if various grades of work are to be done in laboratory, it is almost necessary to make such provision, but I am inclined to advocate a less permanent arrangement than that usually adopted. I should like to see an overhead system of supply with provision for establishing connection with a simple main—provided with the necessary taps—which could be taken down from pegs on the wall whenever required and fixed temporarily on the bench. To call on boys and even on girls to do a little simple gas-fitting occasionally would be to give them most useful training; some one or other would always be forthcoming with genius for such work. I have previously spoken of the importance of giving eye training in schools through surroundings—of the importance of ornament, colour, pictures, &c. Elsewhere, I have urged that an atmosphere of research should prevail in our college laboratories. From the same point of view, I would here advocate that a workshop atmosphere should pervade our school workshops: they should be arranged as and look like workshops—not like drawing-rooms. Teacher and taught should be constantly called upon to meet contingencies and difficulties—to become handy and self-helpful; and instead of being forced to stand or sit at one place during the lesson, the scholar should be encouraged to move to whatever place in the workshop is best suited for the work in hand. I am a teacher of over thirty years' standing. I have taught students of every grade. What astonishes, and indeed appals me, is the absolute inability of almost all the students I meet with to help themselves. I therefore feel that our schools must take the question of hand and eye training seriously into consideration.

For such benches as I have advocated, it is unnecessary to use hard wood. But whatever wood be used in the science workshop for the tops of benches, it should invariably be thoroughly coated with paraffin wax by ironing this in with an ordinary hot iron. Oil is useless as a protection against chemicals.

Sooner or later a wooden bench top always becomes much stained and disfigured; unless it be exceptionally well made, cracks are sure to develop. All these difficulties are overcome by the use of lead-covered benches; a long experience leads me personally to prefer these to all others. The lead should be dressed carefully over the edge of the bench; a *stout* hard-wood bead, projecting about half an inch above the bench top, should then be fixed against it, using cups and screws. A simpler plan is to clamp the lead firmly at its edge by a hard-wood bead screwed down upon the table top an inch or so in from the outer edge of the table. Before fixing the bead the surface to be hidden should be well painted, so as to make a water-tight joint. Solder should never be used in making joints in any lead work; joints should always be burnt with the blowpipe.

A few words may be said here specially with reference to girls' schools. No doubt, until teachers become more imaginative and less anxious to adopt conventional fittings, they will desire to have very formal arrangements made for experimental work. If the teacher insist on having the working benches placed in front of a demonstration table, a water bench

may well be fixed flanking the benches on the one side; whilst on the other flank—assuming the door to be in the middle of the wall—the space on one side of the door may be occupied by draught hoods and that on the other by a balance bench. But provision should be made even in the case of girls for some use of tools. Most householders must have experienced feminine incapacity to understand screws, leading as this does to the gradual disappearance of the screw nuts from domestic appliances; and they must have wished that their womenkind had some soul for such matters. The chief development must come, however, in connection with the rational study of domestic requirements: it may not be necessary nor desirable to teach our girls at school to be cooks: but they *should* learn there to understand the fundamental principles underlying cookery and all other kinds of domestic work—it should be woman's pride to do this. Men have long been victims of academic prejudices, but are seeking to throw them off; unfortunately the disease is now being contracted by women, and we have to deplore the all too literary bent of the curriculum in girls' schools, whether primary or secondary. By making liberal provision of space for domestic workshops, the architect may do much to turn the tide.

With regard to the treatment of wall space, as much as can be spared here and there should be properly prepared so that it may serve as a blackboard; or the special black canvas, so much used in America, should be fixed against it by battens. The old-fashioned small blackboards, like slates, are fast disappearing, with advantage to teachers and taught. Wherever there is spare space, stout battens should be fixed to the wall a few feet apart—when these are provided brackets, &c., may be fixed up at any time.

Lastly, I may point out that if it can be provided a flat roof is very valuable for many purposes—for experiments on the growth of plants, for photographic work, &c. Also that it is desirable that a number of beams be fixed firmly to the ceiling joists, from which pulleys &c. can be suspended.

I have said nothing directly with reference to the science workshops in colleges as distinct from those for schools. In minor matters these differ considerably from school workshops, but not in principle. I have long made up my mind that if I were called on again to design a laboratory, I should greatly simplify the fittings and follow as nearly as possible the model of the well-arranged factory.

The Board of Education has recently issued a series of rules to be observed in planning and fitting up public elementary schools, which include rules for the fitting up of a science room in ordinary schools and also for laboratories in higher grade elementary schools. The latter undoubtedly tend to favour over-provision from the point of view of this paper.* The inspectors who are called on to administer them have usually been brought up in the lap of luxury and have not learnt by sad experience to come down to the level of ordinary life. Large sums are being spent all over the country at the present time under such influences. It is not merely that much more money is spent than necessary: what is far worse, a false complexion is put upon the work—it becomes drawing-room practice and not workshop practice; when the scholars go out into the world, they find themselves placed under altogether strange conditions, unable to use the ordinary tools and unable either to fit into or to follow the ways of ordinary life. The outcome is most serious; some action must be taken to put the schools on a simpler footing and to bring their work into harmony with ordinary requirements. Sir William Abney, the present head of the science branch of the Education Department, is so well aware that what is most wanted in a science workshop is

* It is implied that distinct physical and chemical laboratories are desirable. I venture to urge that the very contrary is the case—there should be no specific mention either of chemistry or of physics in an elementary school, whatever its grade, and scarcely in a secondary school. Science in its relation to common life is the subject that schools should endeavour to teach; this touches on many branches.

space that we may hope that he will so modify the regulations as to make this the essential feature in them; and also that he will emphasise both in the regulations and in instructions to Inspectors the importance of securing simplicity in the arrangements.

In conclusion, I venture to urge that some attempt should now be made to standardise the requirements both for elementary and secondary schools.

DISCUSSION OF DR. ARMSTRONG'S PAPER.

The President, Mr. Aston Webb, A.R.A., F.S.A., in the Chair.

Captain Sir WM. DE W. ABNEY, K.C.B., F.R.S., who was called upon by the President, said that in such an assembly he felt very diffident in saying anything about science fittings; still, he believed he was the first to bring out any fittings at all for a laboratory. More than thirty years ago, when he first went to teach chemistry and physics at Chatham, there was no laboratory there of any description, except a rough shanty of a place, and he, with the help of Mr. Valentine, a well-known teacher, had to get out a plan for fittings. Those they devised were not perfect by any means, but were good of the kind for that period, when there was a great deal of chemical analysis taught, but very little of the other part of chemistry found now to be so necessary. The pupils he had to deal with were of a very varied nature. They began with a bugler and ended with the colonel; so that laboratory accommodation had to be provided to suit all classes of men. They had to guard, for instance, against the possibility of the bugler squirting nitric acid into the colonel's eyes from the opposite side of the bench! That was one reason why they adopted the top-hamper system at their benches, which Dr. Armstrong now condemned. It was necessary to avoid injury to the eyes which he knew from practical experience had taken place on several occasions. When some years ago he came into the office of the Science and Art Department, they had only one or two laboratories; he had lived to see, however, the advent of at least a thousand laboratories all over the country. His first duty at the office of the Science and Art Department had been to get out some kind of working drawings by which people might make benches for fitting up laboratories. He might say that they took as a model those that had already been put up at Chatham, modifying them to a certain extent to meet difficulties which he noted Dr. Armstrong had recognised in his Paper. Where, for instance, advanced work had to be done, a certain amount of water had to be available close to the benches. In a secondary school, such as Christ's Hospital, it was perfectly possible to have two or three sets of laboratories—one for elementary work, one for intermediate work, and one for more advanced work, and so on—but in the laboratories he had to inspect it was impossible to have more than one, so that they had to provide for both elementary and advanced instruction in the same laboratory, and at the time it was thought better that there should be this supply of water on the benches, together with the sinks which had been so well condemned by Dr. Armstrong. He was not going to defend them; they were useful at the time, but, like many other things of ancient history, they had ceased to be of value in the eyes of modern scientists. The Secondary Science branch, of which at the present moment he was the head, had gradually relaxed its rules as regards the fitment of laboratories; it was sufficient almost that there was a table, perhaps little more than the rough stout kitchen-table spoken of by Dr. Armstrong. In old days the Government gave grants for laboratories, for which the schools were liable; and the Government liked to have something tangible that they could seize in case the school did not pay its proper quota. Now, the Government had no lien upon laboratories and fittings, and schools were therefore left with much greater freedom than before. He thought that Dr. Armstrong had been a little rough upon the Board of Education. As regards their requirements he would read the regulations recently issued by the Board—regulations which, he believed, were drawn up with the aid of a distinguished member of the Institute. The science-room, the regulations stated, was to be "a room suitably fitted for elementary practical work in science"—that was pretty wide—and "may be provided for the use of one large or several contributory schools. Such a science-room should not, as a rule, contain more than 600 square feet of floor space"—because the science classes were limited in number. "It should be fitted with strong and plain tables, sinks, cupboards, and shelves, and, where necessary, a fume-closet. A proper supply of gas is necessary. In addition to a science room, one of the ordinary class rooms may be fitted with a simple demonstration table and gas and water supply. But a special lecture room cannot be approved in an ordinary public elementary school." Those (Sir William Abney continued) were the whole conditions that were required for a public

elementary school. As regards the higher elementary schools the conditions were as follows:—"Every higher elementary school should be provided with suitable laboratories." "The laboratory accommodation must be sufficient to provide at one time for the largest class in the school." "There should generally be one laboratory for chemistry and one for physics." He did not think Dr. Armstrong could object to that. "A laboratory should afford 30 square feet of floor space for each scholar; the minimum will therefore be 600 square feet; but it is as a rule desirable that the laboratory should be somewhat larger." Space, again, it would be seen, the Board considered absolutely essential. "If, however, the laboratory accommodates more than twenty-five scholars, a second teacher would be required. Laboratories must be fitted with suitable tables" (what kind was not stated; they might, therefore, be rough kitchen-tables) "which must be well lighted: they should be properly supplied with gas and water. For chemical laboratories sinks, cupboards, and the necessary fume-closets must be provided. A small balance room may be provided if desired. In addition to the class rooms and laboratories a higher elementary school may include a lecture room, which should be fitted with (1) a demonstration table furnished with a gas and water supply and a sink, (2) a fume-closet. A lecture room should have an area of about 750 square feet. If no separate lecture room is provided each of the class rooms used by the third and fourth year students should be fitted with a simple demonstration table," and so on. Those (continued Sir William Abney) were requirements which he thought Dr. Armstrong would allow were pretty free, and would meet his ideas of what a workshop should be. He was not responsible for those rules, but he was for those of the Secondary Branch, which were about on the same lines. He might say that there was the utmost freedom given to architects if there was anything they liked to propose, and he was quite certain that the Board of Education as such would not object to anything in reason. Referring again to the benches, speaking for himself he demurred to doing away with the top hamper. He had not dealt with the same class of students that Dr. Armstrong had; but in his experience as a teacher he would not have been without that protection for the eyes on any account, for where work had been done at benches without such protection some very serious accidents had taken place. He was inclined to think that it was the apparatus-maker that Dr. Armstrong should put into his crucible; it was the apparatus-maker who was responsible for a great many of the defects of the present fittings; and if he could be improved a good work would be done for science. The wooden sink suggested seemed admirable, and it was a good plan to collect the solid sediment at the bottom of the sink rather than to send it down the drain-pipe. As regards the flues, he fully agreed with Dr. Armstrong; so far as he could gather from the description they had been most excellently thought out. Before sitting down he should like to propose a vote of thanks to Dr. Armstrong for his very suggestive Paper, and for the enormous amount of trouble he had taken to bring before them the details of such a well-thought-out scheme as that of Christ's Hospital. It was not often that they had the advantage of hearing Dr. Armstrong on the subject of this practical work. They knew him very well for the great educational work that he had done, and they must thank him very heartily for having descended from what he might call the literary side to the practical side with which they all had to deal.

Mr. W. D. CARÖE, M.A., F.S.A. [*F.*], who rose at the instance of the President, said he had very much pleasure in seconding the vote of thanks to Dr. Armstrong. It was a great pleasure to them to see some of the inner works of the very fine block of buildings which the President had erected at Horsham. It had been his privilege, under the President's and Dr. Armstrong's guidance, to have it explained on the spot, and to see all the fittings about which they had had that evening so very clear and specific a statement. What struck one most with regard to those fittings was their great simplicity; and they should certainly owe a debt to Dr. Armstrong if he could induce others in the same position as himself to lighten the burden of architects who had to devise and supply the extraordinary elaboration of modern science room fittings; in fact, he could conceive nothing that would be better received among them as a body. At the same time he felt he must congratulate the President very heartily on the fact referred to by Dr. Armstrong, viz. that the President had been able to design the buildings at Horsham without regard to the fittings at all in the first instance. It did immense credit to his foresight that everything had turned out so admirably and appropriately. His (the speaker's) own qualifications for making any remarks upon such a technical subject were not very extensive. His connection with it had been mainly in the rather invidious position of criticising the fittings devised by others. He had, however, in order to qualify himself to do that with some prospect of success, consulted a great many science teachers and visited a great many laboratories with the view of finding out what was the best thing to be done in the various branches. The great difficulty which confronted him was that he heard from every science teacher that the other science teachers' way of doing a thing was not the way that he recommended! In the same way in criticising the fittings of laboratories

he found that they always came before him in a very different form and with very different results; and when he ventured to make some suggestion he was always assured that that was what they were recommended to do at South Kensington! Therefore he presumed that even the requirements of South Kensington were not as standardised as, he was glad to know, Dr. Armstrong thought they ought to be. Dr. Armstrong had set the subject before them in a most admirable manner. They had learned something recently of what might be called the politics of modern education. There had been a tremendous series of letters in *The Times* upon the advantage and otherwise of learning Greek in their schools and universities, and he was bound to say he had a fellow feeling with the old literary methods. But while he felt a little alarmed on reading the first page of Dr. Armstrong's Paper, he felt consoled when he came to the second, because there he pointed out, most admirably, that the subject was to be considered purely from the point of view of education, and not with a view to making technical experts of the youth in their schools. Besides simplicity, space was another matter which Dr. Armstrong insisted on as of very great importance. They as architects would gladly provide much more space than they had to do now in buildings of this kind. But in regard to that Dr. Armstrong must remember that this was a question of funds. With regard to the balances, which Dr. Armstrong had specially referred to as being best in the centre of the room, he had been told over and over again by science teachers that it was a matter of the greatest importance that the balance-room should be so placed that the fumes from the laboratory could not enter it. Perhaps the Professor would kindly refer to that question in his reply. He was sure that Dr. Armstrong was right about the use of wooden sinks. He had examined various classes of sinks, earthenware sinks, lead sinks, and even enamelled iron sinks, the latter, of course, used with disastrous results. At Cambridge Professor Liveing preferred, he believed, to use earthenware sinks, and it would be found there that in a good many instances they had lost their glaze. That did not matter, however; all he wanted was a substance which was quite impervious! The question of aspect was one upon which architects, who were not necessarily chemists or physicists, should be enlightened especially. He noticed on the Hertford plan shown that some of the girls faced one way, some the other way, and some a third way. Now there were only four points of the compass, and one of those ways must be, he thought, a way which might not suit all technical teaching, and therefore he ventured to question the arrangement of that plan in several respects, although he said it with bated breath, as he was afraid it was one of the plans which once passed through his hands. The question of ventilation of fume-closets was one that should have their deepest attention. Many would remember the unfortunate accident which happened at Cambridge a year ago, when a demonstrator was killed while experimenting in the combustion room. The cause of the accident, he believed, had never been accurately ascertained, but it was supposed to have taken place from the fact that the fume-closet had a little gas jet in the outlet and that the fumes of the chemical he was experimenting with ignited and blew the whole front of the fume-closet out into his face. It suggested itself at once that the use of gas in such a position ought to be avoided. No doubt matters were greatly simplified by the use of electrical fans, and it was a little surprising that they were not used more often. But there again they were met with difficulties; no one had yet invented an electrical motor which would be even fairly silent with an alternating current, and the alternating current of course was very largely introduced by electrical companies because of its cheapness. That was a strong reason against the use of the alternating current altogether, because there was no doubt that the electrical motor would come more and more into use, and to work in the buzzing sound of an alternating current motor was a most unpleasant and disagreeable process. He should like to ask the Professor's views as to the placing of fume-closets in the windows, which some ten or twelve years ago was a very favourite arrangement, and one that he had heard spoken of very highly indeed. There was, of course, the great advantage of light, and it was a convenient way of disposing of the fume-closets if the windows were brought down to within about three feet of the floor. On the other hand it used up a large amount of valuable wall-space. One of the great innovations which Dr. Armstrong had suggested was the obliteration of the sink from the working table. This was a matter which might be very suitable indeed to classes of boys, but with advanced students in colleges there might be another aspect of the question. One of the most interesting laboratories he knew—the Practical Chemistry Laboratory at Liverpool, erected by Mr. Waterhouse—was in the form of a theatre: there was a working table before the demonstrator's table, and in every row of the theatre there was a working table for each of the students, so that the same experiment could be carried out by everyone in the room at the same time. In cases of that kind, and in cases of examinations, where much moving about might be awkward, the provision of water on the working table could hardly be avoided. If Dr. Armstrong could show how it could be avoided in such cases he for one would be exceedingly grateful, because the difficulty of getting it away, providing

drains, &c., which were not acted upon by the chemical fumes, was very great. They were all very grateful for the interesting and suggestive Paper which Dr. Armstrong had given them, and not least for the views they had had of the admirable building at Horsham.

Mr. JOHN SLATER, B.A. [*F.*], said that Dr. Armstrong's Paper showed them the importance of the scientific and technical education being given at a much earlier age than used to be the case. He could imagine the advantage that Dr. Armstrong would find if his pupils at the Central Technical College came there after a course of training in a school such as that devised for Christ's Hospital at Horsham. He was delighted to hear the remark which fell from Dr. Armstrong, that although it was not his province to consider ornament he nevertheless thought that money spent on judicious ornamentation would always be well spent. That was a fact that could not be too widely made known and insisted upon. In London and in all the large provincial towns their Board schools were admirably fitted and admirably found in all respects; yet the interior aspect of the class rooms was of the dullest possible character. Most towns had art schools doing admirable work: why should not the municipalities endeavour to get these art schools to do something to decorate the Board schools? Such a step would be of the greatest advantage to both. With regard to the many technical details dwelt upon by Dr. Armstrong, the question of sinks was a very important one. It was a curious thing that, although it had been known for centuries that ordinary wash-tubs were best made of wood, until quite recently nobody had thought of using wood for sinks. There was no doubt that wood was the best material. In lead sinks the lead buckled and had to be renewed; but there was no such disadvantage with wood. Again, with regard to blackboards, there was no doubt that Dr. Armstrong was right: the ordinary small blackboard was practically useless for teaching purposes. In a large school with which he had to do, he had the whole of the end of the room next the platform where the master sat covered with cement with a very fine face and then blackened: this was used as a blackboard, and had answered very well. As to the question of warming class rooms and other school buildings, there was no doubt that radiators were a great mistake. Wood fittings near a radiator warped and cracked in all sorts of ways. He agreed with Dr. Armstrong that many difficulties were got over by underground passages with gratings to admit hot air into the room. Ventilation had been much facilitated by the use of fans driven by an electrical motor; and the question of the alternating current would not enter into cases where the school had its own installation. It was only when the companies supplied the alternating current that complications arose, and even then there was no great difficulty in transforming the alternating current into a continuous one.

Mr. J. J. STEVENSON, F.S.A. [*F.*], said it was many years ago since he was appointed to build Professor Liveing's laboratory at Cambridge, and his experience in that and in other cases led him to recommend architects who had such work to do not to go to it with preconceived opinions. Professor Liveing had been waiting for his laboratory for a long time, and had accumulated a mass of data of what he wanted, and had prepared a plan and a rough elevation. He told him that he wanted a factory chimney 100 feet high, and had no objection when asked if he minded its being square. He thought at first of making it like a tower, but afterwards saw that it was best to make it a good honest chimney to a certain degree ornamental. The door was shown to one side, but he had no objection to its being in the centre. He (Mr. Stevenson) considered it his function to carry out practically what Professor Liveing wanted, and to put it in the best architectural form. They had no differences in carrying out the work. After the building was finished, Professor Liveing wanted all the great squares of the windows with stone mullions to be filled with sheets of plain glass; it had been designed with small panes more like an ordinary workshop. They calculated how much more this would cost for window-cleaning, and found that it was not such a sum as made it worth while to make the alteration. The laboratory was ventilated by the chimney he had referred to; Professor Liveing found no fault, but probably a new professor coming would have a good many changes to make in this or the other arrangements to suit his ideas. There was an elaborate system of carrying the ventilation some considerable distances along the ceilings of the rooms to the chimney, in continuous wooden troughs, which he believed worked well. For additional ventilation the rooms were made as far as possible with windows on two sides, so that a draught could be got across them. With regard to the use of wood for troughs, in the Morphological Laboratory at Oxford, which Professor Ray Lankester got built, where small animals were dissected and the cuttings had to be got rid of as soon as possible, Professor Lankester devised a continuous trough in front of the benches, with a slight slope in it, which was intended to clear out and carry off the animal matter dissected. These troughs had to be carried under the floors, and to be accessible in every case. The system, he believed, had worked fairly well. As to wooden troughs and wooden down-pipes, and having as much wood as possible for what one might call the plumbing, all these had been adopted in both laboratories. As regards women having anything to do with jobbing

work, which Dr. Armstrong had referred to, he should like to mention that a young lady he knew had been appointed by Miss Dove, at High Wycombe, to teach the girls all sorts of useful handiwork. He believed they never needed to go outside the school for mending a window or doing little jobs of that kind.

Miss WALTER, Inspector to the Board of Education, South Kensington, who was invited by the President to make a few remarks on the subject, showed a plan of the new science buildings of Colston's Girls' School, Bristol,* which had been passed by the Board of Education. The building, Miss Walter said, had nothing on the lordly scale of the Christ's Hospital workshops, but it contained two big laboratories —one designed mainly for physical, and the other for chemical work, but identically the same in construction. Each contained four working benches about fourteen feet long by two feet six inches wide, with a gangway between them of nearly four feet. A demonstration table two feet wide was placed parallel to the benches at one end of the room; a gangway of about three feet separated this from the front bench. A large blackboard adorned the wall behind the demonstration table, and a long fume cupboard (about five feet long) was placed on one side of the blackboard. Each room measured about thirty-two feet by twenty-six, which gave an admirable size and shape for a laboratory to accommodate something like twenty-four pupils—*i.e.* six at each bench. The Board of Education's requirement of three feet six inches length of bench for each student was for *examination* purposes. The main point in every laboratory was that the teacher should be able to see every pupil, and that every pupil should be able to see the teacher. That axiom really included the other one—that the balances should be in the laboratory, and not in another room set apart for them. The two laboratories she had referred to were provided with long side benches, upon which the balances were to be placed. They would be covered in the manner suggested by Dr. Armstrong. The balances did not require the whole length of the side benches, so one or two fume cupboards were placed along the wall. Besides the two laboratories there was a small room to be used for a preparation room, or to accommodate a few senior girls. It was also fitted with a carpenter's bench. All the work usually done in a separate demonstration room could be done in both these rooms, and the old-fashioned conventional distinction between "theoretical" and "practical" work could thus be avoided. Referring again to the necessity of the teacher being able to see everybody working, in the old days people who did any scientific work were usually at least sixteen. Nowadays pupils began such work at twelve, and even younger, and although they were called students they were really children: hence they might well be guilty of playing if they thought they could not be seen. For the benches at Colston's School there were no high erections for carrying bottles, and the girls worked only on one side of the bench. That was carried out in the scheme at the girls' school at Hertford which Dr. Armstrong mentioned; but at Colston's School everybody faced the same way. Such bottles as were constantly required were placed in three rows on tiles—one across each end of the bench and one along the centre. Although the bench accommodation allowed for twenty-four pupils, who could be worked in twelve groups of two, she believed the aim of the school was to keep the number, if possible, down to twenty, that being quite enough for one teacher to look after. The halving of the benches and allowing pupils to work only on one side also got over the difficulty that Sir William Abney referred to, that the young people might squirt things into each other's faces. That, she thought, was a very important point about a modern laboratory—that the benches should be only $2\frac{1}{4}$ or $2\frac{1}{2}$ feet wide, and that the pupils should face one way. These points were most valuable helps to the teacher.

The PRESIDENT, in putting the vote of thanks, said that he should like to say that when Dr. Armstrong kindly undertook to read this Paper he (the President) did not know that it was his intention to make the school at Horsham the principal illustration. With regard to the laboratories, it was quite true that they were not built to suit Dr. Armstrong's arrangements in the first instance, because at that time there was a science teacher there who had different views. When the building was nearly up to the first floor, very fortunately the Royal Society appointed Dr. Armstrong as one of the governing body of the Hospital, and the internal arrangement of the science building was altered to meet the views of Dr. Armstrong; and he was quite sure that the Hospital owed a great debt of gratitude to him for what he had done in modelling these rooms. Of course, in a case of this sort the architects really had but a small work to do. They were responsible for the position of the science school, and giving it an importance in the building scheme which, as Dr. Armstrong said, had not generally been given, a science school being usually stowed away in an out-of-the-way part of the buildings. But after that was done, the work devolved almost entirely upon Dr. Armstrong. The fittings he had shown that evening were carried out entirely from his instructions, and they merely acted as draughtsmen in drawing them out. The great change made was the sweeping away of the class rooms and lecture rooms previously arranged for, and providing the

* Head Mistress: Miss Hughes. The architect of the building was Mr. Gough, of Bristol.

large laboratories with space for the classes to take place in the workshop itself. As a matter of fact, in that particular school there was not a lecture room in any part of it. There were simply class rooms and large halls and workshops of the kind described. With regard to fittings, and especially sinks, he (Mr. Webb) had had a great many of these fittings to do under different professors at other places, and he had been impressed with the large use they made of tar. They liked all the sinks and drains to be tarred, and so too the troughs which carried the waste from the sinks under the desks: all agreed that the best way was the V-shaped wood troughs, tarred inside. In another case he was trying to utilise a mixture of tar and sand for the joints of the drain pipes, because this pitch and tar seemed to be less affected than anything else by the acids thrown down the sink. It was an extremely simple and inexpensive thing, and, as Dr. Armstrong said, the plumber had nothing to do with it—although, with regard to that, he thought that a good plumber was a most excellent individual, though a bad one was of course a *very* bad one. As regards the heating of the laboratories he could not agree with Mr. Slater that pipes under the floor, with a grating over them, were the best system. They should be brought above the floor. He was inclined to think that the plenum system of warm air, admitted under slight pressure, was the best means of heating the rooms, because it disposed of the difficulty of hot and cold iron which in a physical laboratory especially was a great difficulty. By using the plenum system they got rid of all fittings entirely, and in one large instance, now being carried out, the plenum system had been adopted for that reason. But at Horsham, where the buildings were of such an extended character and so scattered, it would have been impossible—or at least they came to that conclusion—to adopt the plenum system successfully.

Dr. ARMSTRONG, in the course of his reply to the discussion, said it was a peculiar pleasure to him to hear Sir William Abney speak on this matter, knowing, as he did, the extraordinary services Sir William had rendered to the cause of practical work in this country. Sir William Abney had been behind the scenes the whole time, and, more than any man, almost alone, had exercised a most important influence in developing practical scientific teaching in the schools controlled by his Department. If he (Dr. Armstrong) had criticised the regulations of the Board of Education at all, it was with the object of leading to a stopper being put, so to speak, upon the enthusiasm of some of those who had to look after the fitting-up of laboratories in schools; because although, when interpreted by Sir William Abney, the regulations which had been laid down could not be objected to, yet there was no doubt that those regulations had too often led to excesses when administered by people who had been a little less thoughtful and were far less accustomed to work in simple ways. Sir William Abney's laboratory ought to have been photographed and carefully recorded by Sir Benjamin Stone before it was destroyed some years ago. It was a curious shanty erected in the corner of a lumber room in South Kensington, and in that shanty some of the most accurate scientific work had been done that could possibly be done. A man who could work so successfully as Sir William did under such conditions was not likely to put too high an interpretation upon rules such as had been recently issued; but men brought up under different conditions would not interpret them so judiciously. With regard to the questions put to him, Mr. Caröe stated that he had been told that the balances must be so placed that the fumes could not get at them. Now, however delicate the construction of a balance might be, he thought that the construction of young people's lungs was still more delicate, and that young people ought not to be put in a place where a balance could not be put with safety. If they could put young people into a laboratory, they ought to be able to put balances there. Fume closets in the windows worked admirably in many cases. The latest laboratory built in Germany, Professor Fischer's in Berlin, had all the fume-closets arranged in the windows. It was a very good arrangement to adopt in many cases, but he did not think that, as a rule, such an elaborate arrangement was required for ordinary schools. As to sinks being required in colleges more than in schools, that was entirely a question of taste; in fact, most of these moot points were questions of fashion. A person having been accustomed to one particular thing wished to have it, and would not have something else. So much depended on what one had been accustomed to. He had practically no sinks on the benches in his laboratory for advanced students. If sinks were to be fixed at all in direct connection with the benches, they should be at the ends and not on the benches: it was a common practice so to place them at the present day. In referring to the question of heating, his only object was to point out how seriously radiators or heating-pipes fixed above the floor interfered with the fittings and were in the way. If anyone wished to see how simply, and at what slight cost, ordinary rooms could be adapted for experimental work, he would advise him to go to the Central Foundation Girls' School in Spital Square, and see what was done by Miss Walter there several years ago. At a very small cost indeed, she made two ordinary rooms available, in a most admirable way, for all the work that school children need be called upon to do; and she found a single sink in each room sufficient.

9, Conduit Street, London, W., *24th Jan.* 1903.

CHRONICLE.

The President's "At Home."

The "At Home" given by the President on Monday evening the 12th inst. was perhaps the most agreeable function ever held in connection with the Institute. Members to the number of nearly four hundred met together from all parts of the country, and the rooms were full to overflowing. This was the first occasion of a social reunion of the kind, and in bringing it about in so happy a manner the President was giving practical shape to an idea expressed in his Address last November—viz. that members should have an opportunity of meeting together in a friendly way and of becoming better acquainted with one another than was possible at the formal meetings of the Session. By the kindness of Mrs. Bentley, the President was able to afford his guests the pleasure of a closer acquaintance with the work of the late Mr. J. F. Bentley. On view in the rooms was a numerous collection of designs and working drawings of some of his principal buildings, church altars, church ornaments, screens, sculptured work, &c., mostly from the master's own hand. For the information of those who would like to study the works themselves as carried out in brick and stone, the following list is given of the drawings: St. Mary's, Clapham; St. Mary's, Chelsea; St. Mary's, Kensal New Town; St. Mary of the Angels, Bayswater; Church of the Holy Rood, Watford; St. James's, Spanish Place; St. John's, Brentford; St. John's, Hammersmith; Roman Catholic Church, Doncaster; St. Luke's, Chiddingstone Causeway; The Preparatory School, Beaumont; St. Thomas's Seminary, Hammersmith; Franciscan Convent, Braintree; Carlton Towers; Designs for Monuments to Cardinal Manning and Lady Alice Gaisford; Design for Monument at Stonyhurst College; House at Bainbridge, Yorks; Cottages at Bramley, Guildford, &c. There were also specimens of hangings in velvet and other material designed by Mr. Bentley specially for Carlton Towers. The drawings remained on view during the whole of Tuesday, the 13th inst., and attracted numerous visitors to the Institute.

THE PRIZES AND STUDENTSHIPS 1903.

The Council's Deed of Award.

To the General Meeting, 19th January 1903.

Gentlemen,—Pursuant to the terms of By-law 66, that the Council shall, by a Deed or Writing under the Common Seal, award the Prizes and Studentships of the year, and announce such awards at the next General Meeting after the adjudication, the Council have the honour to state that they have examined the several works submitted for the two Silver Medals of the Royal Institute, the Soane Medallion, the Owen Jones and Pugin Studentships, the Godwin Bursary, the Tite Prize, the Cates Prize, and the Grissell Gold Medal.

The Royal Institute Silver Medals.

(i.) *The Essay Medal and Twenty-five Guineas.*

Three Essays on the subject "A Comparative Review of the Various Past and Present Systems of Architectural Training at Home and Abroad" were received for the Silver Medal under the following mottoes:—

1. "All British."
2. "Ars quatuor coronatorum."
3. "Lindis."

The Council regret that they are unable to award the Medal, but they have granted a Certificate of Honourable Mention to the author of the Essay bearing the motto "Ars quatuor coronatorum" [*Arthur Troyte Griffith, The Priory Gateway, Malvern*].

(ii.) *The Measured Drawings Medal and* £10. 10*s*.

Three sets of Drawings were sent in of the several buildings indicated, and under mottoes, as follows:—

1. Iago:—5 strainers (Balls Park, Hertford).
2. Nix:—6 strainers (St. Martin's-in-the-Fields).
3. Philabeg:—5 strainers (Craigievar Castle, Aberdeenshire).

The Council award the Silver Medal and Ten Guineas to the delineator of Craigievar Castle, submitted under the motto of "Philabeg" [*Andrew Rollo, 2 Willoughbank Crescent, Glasgow*].

The Travelling Studentships.

(i.) *The Soane Medallion and* £100.

Twenty-one Designs for a Town Church were submitted, under the following mottoes:—

1. Advance!—8 strainers.
2. Bee:—7 strainers.
3. "Como":—4 strainers.
4. E Natura Architectura:—6 strainers.
5. "Fides":—5 strainers.
6. Fioretto:—4 strainers.
7. Ich Dien:—7 strainers.
8. ΙΧΘΥΣ:—6 strainers.
9. Lauda Finem:—7 strainers.
10. Medici:—6 strainers.

11. "Neni":—7 strainers.
12. "Ne Oubliez":—7 strainers.
13. "New Era":—7 strainers.
14. ΦΟΙΝΙΞ:—6 strainers.
15. Perseverando:—6 strainers.
16. "Rodari":—7 strainers.
17. Sanctus:—8 strainers.
18. Xerxes:—6 strainers.
19. X, on light blue strainers:—5 strainers.
20. X, on grey strainers:—5 strainers.
21. Device of a Patriarchal Cross:—8 strainers.

The Council have awarded the Medallion and (subject to the specified conditions) the sum of One Hundred Pounds to the author of the design bearing the motto "ΙΧΘΥΣ" [*Edwin Francis Reynolds, Malvern House, Trinity Road, Birchfield*]; and Medals of Merit to the authors of the designs bearing the mottoes "Como" [*Frank Charles Mears, 65 Sydney Street, South Kensington, S.W.*] and "X," on grey strainers [*Cyril Wontner Smith* [*A.*], *Grasmere, Hendon Lane, Finchley, N.*].

(ii.) *The Owen Jones Studentship and £100.*

Three applications were received for the Owen Jones Studentship from the following gentlemen:—

1. L. R. Guthrie:—6 strainers.
2. James M'Lachlan:—6 strainers.
3. Percy E. Nobbs:—2 strainers.

The Council have awarded the Certificate and (subject to the specified conditions) the sum of One Hundred Pounds to *Mr. Percy Erskine Nobbs, M.A.Edin.* [*A.*], *8 Trafalgar Square, Chelsea, S.W.*; and a Medal of Merit and £10. 10*s.* to *Mr. L. Rome Guthrie, 37 Albert Street, Regent's Park, N.W.*

(iii.) *The Pugin Studentship and £40.*

Eight applications were received for the Pugin Studentship from the following gentlemen:—

1. J. Harold Gibbons:—6 strainers.
2. W. S. A. Gordon:—5 strainers.
3. Stanley H. Hamp:—7 strainers.
4. O. P. Milne:—5 strainers.
5. F. C. Mears:—6 strainers.
6. A. Muir:—6 strainers.
7. J. Myrtle Smith:—6 strainers.
8. P. J. Westwood:—6 strainers.

The Council have awarded the Medal and (subject to the specified conditions) the sum of Forty Pounds to *Mr. John Harold Gibbons* [*A.*], *Guardian Assurance Buildings, 25 Cross Street, Manchester*; and a Medal of Merit and £10. 10*s.* to *Mr. Andrew Muir, 29 Newington, Liverpool.*

(iv.) *The Godwin Medal and £65.*

Four applications were received for the Godwin Bursary from the following gentlemen:—

1. H. B. Creswell.
2. H. Phillips Fletcher.
3. A. Dunbar Smith.
4. A. Maryon Watson.

The Council have awarded the Medal and (subject to the specified conditions) the sum of £65 to *Mr. A. Dunbar Smith.*

(v.) *The Tite Certificate and £30.*

Fourteen Designs for a Pavilion in a Public Garden were submitted under the following mottoes:—

1. Altiora:—6 strainers.
2. Archivolt:—8 strainers.
3. Ariel:—5 strainers.
4. Caber-feidh:—5 strainers.
5. Forum:—7 strainers.
6. "Le Nord":—8 strainers.
7. Lindisfarne:—4 strainers.
8. "Lux":—4 strainers.
9. Mime:—8 strainers.
10. Mulciber:—4 strainers.
11. Pax:—7 strainers.
12. Phœnix:—4 strainers.
13. Queen of Hearts:—5 strainers.
14. St. Winifred:—5 strainers.

The Council have awarded the Certificate and (subject to the specified conditions) a sum of Thirty Pounds to the author of the design bearing the motto "Caber-feidh" [*David Smith, 62 Sternhold Avenue, Streatham Hill, S.W.*].

THE CATES PRIZE: £40.

Two applications for the Cates Prize were received from the following gentlemen:—

1. Baxter Greig:—11 strainers.
2. A. Halcrow Verstage:—22 strainers.

The Council have awarded the Cates Prize of £40 to Mr. A. Halcrow Verstage [*A.*], Meadrow, Godalming, Surrey.

PRIZE FOR DESIGN AND CONSTRUCTION.

The Grissell Gold Medal and £10. 10s.

Eleven designs for a Stone Dome over a Porte-cochère to a large Public Hall were submitted under the following mottoes:—

1. Blunderbuss:—3 strainers.
2. Civic:—3 strainers.
3. "Duomo":—2 strainers.
4. Golden Horn:—3 strainers.
5. H.I.M.—2 strainers.
6. Notts:—2 strainers.
7. Quercus:—4 strainers.
8. Red Rose:—2 strainers.
9. "Sepia":—4 strainers.
10. White Rose:—4 strainers.
11. "Z":—4 strainers.

The Council have awarded the Medal and Ten Guineas to the author of the design bearing the motto "White Rose" [*Jas. B. Fulton, East Chapelton, Bearsden, Glasgow*].

THE ASHPITEL PRIZE 1902.

The Council have, on the recommendation of the Board of Examiners (Architecture), awarded the Ashpitel Prize to Mr. William Greenwood, of Blackburn. Mr. Greenwood was registered *Probationer* in 1900, *Student* in 1901, and passed the Final Examination in November 1902.

THE TRAVELLING STUDENTS' WORK.

Owen Jones Studentship 1901.—The Council have approved the drawings and design of Mr.

J. Hervey Rutherford, who was awarded the Studentship in 1901, and who travelled in Italy, Sicily, and Spain.

Owen Jones Studentship 1902.—The Council have approved the drawings and design of Mr. Edward H. Bennett, who was awarded the Studentship in 1902, and who travelled in Italy and Spain.

Godwin Bursary 1902.—The Council have approved the Report of Mr. Chas. A. Daubney [*A.*], *Godwin Bursar* 1902, who visited the United States of America to study Fire Escapes in American Commercial Buildings.

Pugin Studentship 1902.—The Council have approved the work of Mr. C. Wontner Smith [*A.*], who was elected Pugin Student for 1902, and who travelled in Gloucestershire.

Tite Prize 1901.—The Council have approved the work of Mr. Walter Fairbairn, who was awarded the Tite Prize for 1901, and who travelled in Italy.

In witness thereof the Common Seal has been hereunto affixed this Nineteenth day of January 1903, at a Meeting of the Council.

(*Signed*) ASTON WEBB, *President*; JOHN SLATER, EDWIN T. HALL, EDW. A. GRUNING, *Members of Council*; ALEXANDER GRAHAM, *Hon. Secretary*; W. J. LOCKE, *Secretary*.

Chipping Wycombe Municipal Buildings Competition.

The conditions for the above competition contain the following clause:

"The President of the Royal Institute of British Architects, or some architect to be nominated by him, will be asked to make these awards according to his judgment; but the Corporation do not undertake to carry out any designs, and reserve the right to select for erection any set of designs (whether awarded a premium or not) they may themselves prefer."

The President desires to inform members of the Institute that, as he understands the promoters decline to modify this clause, he has been unable to nominate an assessor.

The late J. F. Wadmore [*A.*].

Mr. James Foster Wadmore, of Dry Hill, Tonbridge, who died 3rd January 1903, had been an Associate of the Institute since 1865. The following notes of his career have been kindly contributed by his son, Mr. Beauchamp Wadmore [*A.*]. He was the eldest son of James Wadmore, and was born on 4th October 1822. His father was a well-known and enthusiastic collector of pictures, books, prints, and medals, of which the greater part was sold at his death in 1853. Mr. J. F. Wadmore was educated at the Free Grammar School, Tonbridge, and subsequently studied under a private tutor in Berkshire. In 1843 he was articled for three years to the late Mr. William Grellier, and during his pupilage he attended Professor Donaldson's lectures at the London University. At the termination of his articles he gained the Medal of Merit given by the Institute for the best design for a Chapel Royal, the prize being presented to him by Earl De Grey, then President. Shortly after, he set up in business at Crosby Chambers, E.C., one of his first works being the Church of St. Michael and All Angels at Sutton Coldfield. In 1854 he removed his office to 35 Great St. Helens, and took into partnership his old schoolfellow (the late Mr. Arthur J. Baker). The early years of their partnership they devoted to competition work, such as the plans for the Foreign Office and other metropolitan improvements, and, though unsuccessful, established the reputation of their firm for good work. Mr. Wadmore designed and subsequently decorated St. Mary's, Mistley; restored St. Helen's, Bishopsgate Street; the churches at Tudeley, Kent, and Denford, Northampton, as well as the School Chapel (in 1859) at Tonbridge. With the late Mr. E. H. Burnell, surveyor to the Skinners' Company, he designed and carried out, in 1863, the new school buildings at Tonbridge School, the Skinners' Middle School for Boys at Tunbridge Wells, and the Middle School for Girls at Stamford Hill. In domestic work the pick of his designs will be found at Mistley Place, Essex, and Ferox Hall, Tonbridge. In 1888 his partner, Mr. Baker, retired, and in 1890 he was joined by his son, Mr. Beauchamp Wadmore, and Mr. William Robert Mallet, with whom he continued in business to the date of his death, though not a very active member of the firm. Mr. Wadmore was a member of the Skinners' Company and Senior Past Master at the time of his death, a Governor of Tonbridge School, the last Chairman of Old Fulham Bridge, and a member of the Council of both the Kent and London and Middlesex Archæological Societies, for whom he wrote several papers, among others the account of the Skinners' Company which was later largely added to and published in two editions dated 1876 and 1902; "Tonbridge Castle and its Lords"; "Old Fulham Bridge"; "St. Mary Magdalen's Priory, Tonbridge," &c.

REVIEWS.

ESTIMATING COST.

"*How to Estimate: being the Analysis of Builders' Prices.*" *By J. T. Rea.* 8o. *Lond.* 1902. *Price* 7s. 6d. *net.* [*B. T. Batsford, 94 High Holborn.*]

It may be accepted as a maxim that considerations of cost rule the world; but if the general truth of the proposition needs accentuation, it can at once be demonstrated by simply enumerating the meagre list of ethical principles in the human philosophy of well-regulated communities that are not influenced by questions of cost. Accepting, then, as a modern law what we may well believe in the remote past was a mere con-

vention, it is not remarkable that counting the cost should now be an important and unavoidable branch of an architect's work. Happily, in the matter of estimates there is expected, and sometimes cheerfully allowed, a five or ten per cent. margin for unforeseen contingencies, regrettable oversights, or whatever we may be pleased to term the difference between fiction and fact, and so at the completion of a building in due course the final certificate is issued with a sigh of relief, enshrouding maybe a pious though silent hope that the client is enjoying full value for his money, and the builder a fair price for his work. We have before us a book that sheds much light upon the cost of many things—no mere schedule of prices, but a work exhibiting a serious attempt to treat scientifically the principles of estimating.

Memory recalls from the past several useful works on builders' prices, and one in particular, entitled "Estimating," published by Batsford twenty years since on emerging from publication in serial form, in surroundings, if we remember rightly, similar to those enjoyed by the work now in review. The earlier book dealt with the subject in analytical form in an admirable manner. Mr. Rea's work is, as a new book should be, a decided step forward. The excellence attained is rather in the manner of marshalling the facts than in the newness of them. The author has a concise and crisp style. Note how he deals with the cost of water-waste preventers: "There are many varieties of cast-iron water-waste preventing cisterns from 8s. 6d. to £3 each; a good one costs 21s., and should hold three gallons." To ascertain the cost of such an item fixed, to the prime cost must be added the cost of brackets, chain, and ring, the labour in fixing, the labour and material in plumber's joints, and finally contractor's profit, the total producing the cost of the cistern fixed.

Again: to find the cost per foot superficial of deal or other woods in thicknesses we have set out the initial cost at the docks of a standard of St. Petersburg deals, the landing rate, loading charges, cartage to mills, cost of sawing, and estimate of waste, from which, by the aid of arithmetic and the data in the book, we arrive at the net cost per foot super. of any thickness of deal. Proceeding again from the price per foot super. as a basis, the cost of planing, whether by machinery or hand labour, is now added; then the constants of labour are brought into the calculation; something is added for waste and sundries in nails, glue, sandpaper, &c.; then comes the cost of framing and fixing; the while not forgetting contractor's profit, we may arrive on these scientific principles at the price of any item of joiner's work from a deal ledged door to the most elaborate piece of hardwood joinery.

An interesting feature in the chapter upon the various methods of estimating the cost of buildings is a schedule of cost per cubic foot at which some forty differing classes of public buildings may be erected. Another schedule discloses the actual cost of some sixty well-known public buildings at per cubic foot, and the cost per unit of beds in the case of hospitals and asylums, at per seat for theatres and churches, at per room for model dwellings, and at per quarter for breweries. From these details the author turns to the subject of mechanics' labour, and explains the use to be made of the constants given in the subsequent calculations. The author's arrangement is logical: the chapter upon each trade opens with memoranda; then follow a series of prices for materials and labour at the various units of measurement, technically known as measured work prices. Next in order are prices of materials "supplied only" in day work. Finally, we come to the scientific analysis of measured work prices. This sequence is observed in each trade, and no detail involving cost has the author considered too unimportant to be noted.

It may be that most of the standard text-books have been drawn upon in some measure for this work—where possible the sources are acknowledged; nevertheless, the matter has never before been brought together in so useful a form.

In considering the prices affixed to the various items it is well to note an important qualification. The author rightly warns his readers "that prices of most building materials have gone up from twenty to thirty per cent. within the last few years, chiefly through 'rings' and 'corners' creating artificial values: this constant fluctuation must be borne in mind in reading this book, for what may be right this week may be wrong next, owing to the sudden change in the market."

However this may be, the principles of estimating as set forth so ably still hold good. The variable values may be stated as—the initial cost of the raw material, the rate of wages, and local circumstances. Bearing these considerations in mind, one can turn to any part of Mr. Rea's book and find reliable data. To all concerned in the cost of builder's work this book should prove intensely interesting, to students it is invaluable, and to the author himself it is a monument of conscientious labour freely bestowed with great skill upon a highly technical branch of professional practice. SYDNEY B. BEALE.

ALLIED SOCIETIES.

SHEFFIELD SOCIETY OF ARCHITECTS.

At the ordinary monthly meeting of the Sheffield Society of Architects, held in the Rooms of the Literary and Philosophical Society, Leopold Street Sheffield, Thursday, 8th January, Mr. F. M. Gibbs [*F.*] delivered a lecture on "A short visit to the United States and Canada."

Mr. Gibbs explained that his visit had been a hurried one of only thirty-one days from Liverpool,

of which eighteen days were spent in America, and that it was made for a holiday and a change, and that he had not made any effort to obtain any special information except as to the University buildings, and was not prepared with a lecture, but only a series of views of buildings in New York, Washington, Montreal, and Boston, supplemented by some casual remarks. In presenting views of New York he drew attention specially to the skyscrapers, and stated that they had the quality of architectural dignity so eulogised by Ruskin as "The Lamp of Power," which was due not only to their great size but to the simplicity of design and the beautiful grey granite with which they were encased. Internally many of them were rich in marbles, and several were provided with post and telegraph and messenger offices, newspaper and barbers' shops, flower stalls and restaurants, and one had a railway station attached to it. The rents for an ordinary office, say five yards square, varied from £500 on the lower, to £100 per year on the upper floors, including lighting and heating. Some of the land had cost £350 a yard, and there was said to be no difficulty in forming companies, with a promised dividend of 4 to 5 per cent., to purchase sites and erect the buildings. Most of them had been erected within the past ten years. The Park Row building has thirty stories, and is 390 feet high, the foundations being 70 feet deep. The damage by skyscrapers to the light of adjoining buildings is substantial, but as in America the law gives no protection against this, and electric light is in such universal use, there is apparently no complaint. In the views of Boston Mr. Gibbs drew attention to the Public-Library, which is built of grey granite, and cost £500,000, one of the best examples of the work of the late Mr. Hunt; and also to the Symphony Hall, which has seats for 2,680, and cost £100,000, and which is specially well arranged for convenience of access and egress by corridors all round on each floor, and has a most complete ventilating apparatus. As regards the University buildings, sites were all much larger than at present required; in each case a good general plan had been adopted, and the buildings were being erected gradually as funds came in; separate buildings were erected for separate departments, and very frequently gifts of buildings had been made by gentlemen specially interested in one department; as an instance he exhibited the plans and views of "The Robinson Hall" at Harvard University, which was for the Department of Architectural Education. Mr. Gibbs also referred to his visits to the Architectural Department at Columbia University, Massachusetts Technological Institute, and to Montreal University, and suggested that in the new University buildings to be erected in Sheffield some provision should be made for architectural education. With regard to the allegation that the American bricklayer laid more bricks than the British bricklayer, Mr. Gibbs pointed out that it was not generally known that the American brick was only 8 inches by 3 inches by 2 inches thick, which, as compared with the Sheffield brick of 9 inches by 3 inches by 4½ inches, was less than half the size and weight. Speaking generally of the architecture of the United States, Mr. Gibbs thought that the finishing of the education of many of their architects in the Paris schools of architecture had a beneficial effect, and accounted for much of their good planning and dignified architecture.

MINUTES. VI.

At the Sixth General Meeting (Business and Ordinary) of the Session 1902-03, held Monday, 19th January 1903, at 8 p.m., the President, Mr. Aston Webb, A.R.A., F.S.A., in the Chair, with 26 Fellows (including 11 members of the Council), 34 Associates (including 3 members of the Council), 1 Hon. Associate, and visitors, the Minutes of the Meeting held 15th December 1902 [p. 135] were taken as read and signed as correct.

The following Associates attending for the first time since their election were formally admitted by the President and signed the Register—viz. Thomas William Whipp, Baxter Greig, Richard Fielding Farrar, James Herbert Belfrage.

The decease was announced of the following members:—William Wimble [*F.*], elected 1888; James Foster Wadmore [*A.*], elected 1865; Albert Charles Breden [*A.*], elected 1892.

The Hon. Secretary formally announced the receipt of a number of works presented to the Library, a list of which was given in the last *Supplement*; and also the receipt of a contribution of £5 to the Library Fund from Mr. Sydney Smirke [*F.*], this being his fourteenth annual donation of a like sum to the Library. Whereupon, on the motion of the Hon. Secretary, a vote of thanks was passed to the various donors, with special mention of the name of Mr. Sydney Smirke.

The following candidates for membership were elected by show of hands under By-law 9—viz.:—

As Fellows (2).

THOMAS EDGAR ECCLES [*Assoc.* 1890] (Liverpool).
WILLIAM CHASEN RALPH (Wigan).

As Associates (3).

ARCHIBALD LAWRENCE HOLDER [*Probationer* 1898, *Student* 1900, *Qualified* 1902].
HORACE MOGER [*Probationer* 1894, *Student* 1898, *Qualified* 1902].
JAMES MACLAREN ROSS [*Probationer* 1896, *Student* 1898, *Qualified* 1902].

The Secretary having read the Deed of Award of Prizes and Studentships 1903, made by the Council under the Common Seal [p. 184], the sealed envelopes bearing the mottoes of the successful designs and drawings were opened and the names of the authors declared.*

A Paper by Professor Armstrong, LL.D., Ph.D., F.R.S., on Science Workshops for Schools and Colleges having been read by the author and illustrated by lantern slides, a discussion ensued, and a vote of thanks was passed to Professor Armstrong by acclamation.

Announcements having been made by the President as to the opening of the Annual Exhibition of Drawings and as to the business of the next General Meeting, the proceedings closed and the Meeting terminated at 10.15 p.m.

* These names are now printed between brackets in the Deed of Award, p. 184, after the mottoes.